

PHM-109 INTRACRANIAL PUMP

USER'S MANUAL



PHM-109 Head Pump Manual
DOC-042
Rev. 1.1

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CHAPTER 1

Introduction

The PHM-109 Intra-Cranial Pump is a head-mounted nanoliter injection system for delivering compounds directly into a rat brain. The pump is mounted on the animal's head and the animal can move freely, since a swivel supports the pump. The short distance between the pump and the animal's brain allows the system to deliver consistent volumes. The PHM-109 pump is controlled by a stepper motor, and can be operated either manually or through MED-PC®.

It is important that this manual be read thoroughly prior to operating this equipment.

Warnings and Cautions

WARNING: The SG-216A cable supplies power to the pump when connected to a MED-PC Output, therefore it is not necessary to use the 28 VDC Inverter concurrently. Connecting the 28 VDC Inverter and the SG-216A cable to the Pump Controller concurrently may cause equipment damage.

NOTE: It is recommended that the maximum number of steps per infusion be 200. The pump will not function properly if this number of steps is exceeded, as it will reach the end of its travel and may burn out the pump motor.

NOTE: If the jumper on the J1 connector inside the Pump Controller (Figure 2.15) is in the 2.1 or 2.2 position, the pump will be operating at $\frac{1}{2}$ or $\frac{1}{4}$ step. It is important to note that the volume infused per step will decrease accordingly.

CHAPTER 2

Installation Instructions

Hardware Guide

Figure 2.1 - PHM-109 Pump



Figure 2.2 - Multi-Channel Commutator



Figure 2.3 - Pump Controller Front Panel

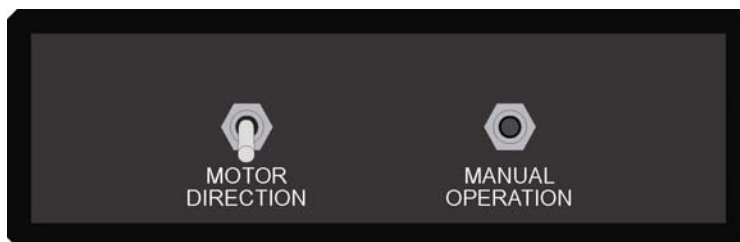


Figure 2.4 - Pump Controller Back Panel

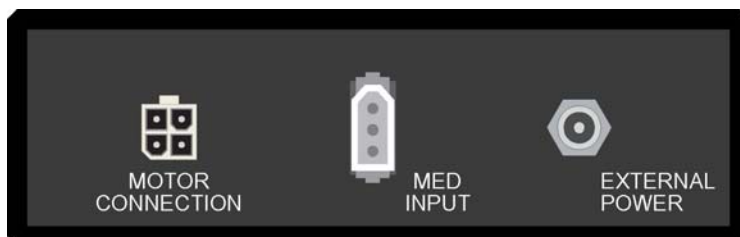


Figure 2.5 - Swivel Assembly



Cable Guide

Figure 2.6 - Pump Controller Cable



Figure 2.7 - SG-216A Cable (Only Used if Controlling the Pump with MED-PC)



Figure 2.8 - 28 VDC Inverter (Only Used if Operating the Pump in Manual Mode)



Installation Instructions

1. Install the Swivel Assembly (Figure 2.5) in the desired location on the animal chamber.
2. Remove the two screws and the retaining bar at the end of the swivel assembly, shown in Figure 2.9.

Figure 2.9 - End of Swivel Assembly



3. Place the Multi-Channel Commutator (Figure 2.2) in the slot at the end of the Swivel Arm and reinstall the retaining bar and screws as shown in Figure 2.10.

Figure 2.10 - Multi-Channel Commutator Installed on the Swivel Arm



4. Using the Controller Cable (Figure 2.6), connect the **MOTOR CONNECTION** port on the Pump Controller (Figure 2.4) to the connectors on the Multi-Channel Commutator indicated in Figure 2.11. The end of the controller cable that connects to the Commutator has two connectors, one white and one red. The red connector should be plugged in to the red port on the Commutator, indicated in Figure 2.11 and white to white. The connectors are also marked with black lines that indicate how the pins of each connector should align.

Figure 2.11 - Connect to MOTOR CONNECTION



5. Connect the cable that extends from the PHM-109 pump, shown in Figure 2.12, to the connectors on the Multi-Channel Commutator indicated in Figure 2.13. Again, the red connector plugs into the red port and the white connector into the white port. The black lines indicate proper pin orientation.

Figure 2.12 - PHM-109 Pump Cable



Figure 2.13 - Connect to PHM-109 Pump Cable



If Controlling the Pump with MED-PC

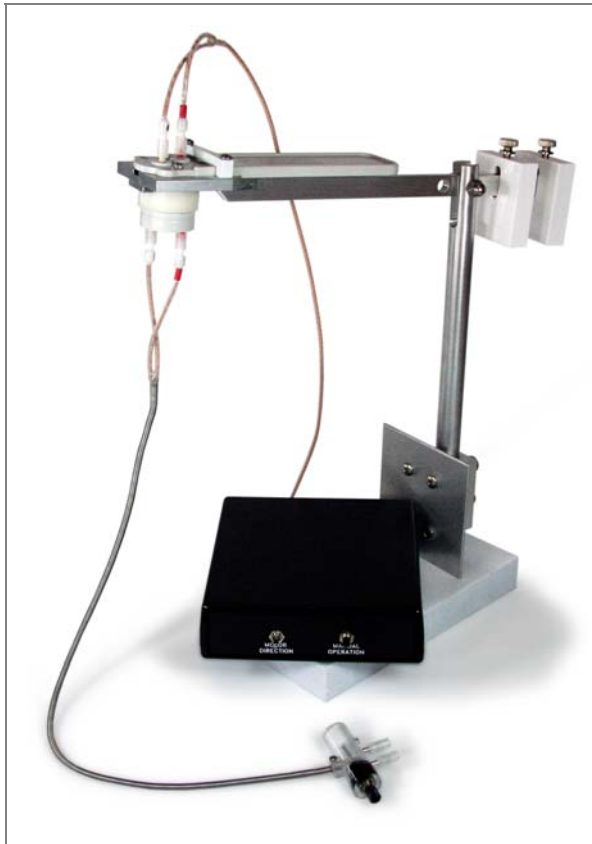
WARNING: The SG-216A cable supplies power to the pump when connected to a MED-PC Output, therefore it is not necessary to use the 28 VDC Inverter. Connecting the 28 VDC Inverter and the SG-216A cable to the Pump Controller concurrently may cause equipment damage.

6. Using the SG-216A cable (Figure 2.7), connect the **MED INPUT** connector on the pump controller (Figure 2.4) to a MED-PC **Output**.

If Operating Pump in Manual Mode

6. Connect the 28 VDC Inverter (Figure 2.8) to the **EXTERNAL POWER** connector on the Pump Controller (Figure 2.4). The pump is now ready to operate.

Figure 2.14 - Completed PHM-109 Pump Assembly



J1 Jumper Settings

Figure 2.15 - J1 with Jumper in the 1.1 Position



The J1 connector inside the Pump Controller (Figure 2.15) has a pin jumper whose position can change the function of the pump based on the needs of the user. The top four sets of pins (1.1, 1.2, 1.4 and 1.8 reading down the left in Figure 2.15) control the pump speed when operating in manual mode. The jumper position and the corresponding speed, in steps per second, are as follows:

Jumper Position	Step Size
No Jumper	0.5
1.1	1
1.2	2
1.4	4
1.8	8

The set of pins labeled “Agnd” are not used. The bottom two sets of pins (2.1 and 2.2 reading down the left in Figure 2.15) control the step size of the motor. The jumper position and corresponding step size are as follows:

Jumper Position	Step Size
No Jumper	Full Step
2.1	½ Step
2.2	¼ Step

Volume Infused per Step

When controlling the pump with MED-PC the user can control the number of motor steps per infusion. The PHM-109 Intracranial Pump infuses approximately 23 nanoliters per step. However, it is advisable that each pump be validated prior to use. The recommended method for validation is as follows:

1. Except for a 2-mm air space, fill a length of tubing with a colored liquid (water colored with blue vegetable dye for example) and attach it to the tip of the syringe needle. The 2 mm air space should be placed at the start of the line. The inner diameter of the tubing must be known.
2. Calculate the volume contained in 1 cm (10 mm) of tubing.

$$\text{Inner Diameter} / 2 = r \text{ (Inner Radius)}$$

$$\text{Volume of a Cylinder} = \pi r^2 L$$

Where **L** is the length of tubing, which is 1 cm in this case. For example, if tubing with an inner diameter of 0.58 mm is being used, then:

$$0.58 \text{ mm} / 2 = 0.29 \text{ mm} = r$$

$$\text{Volume contained in 1 cm (10 mm) of tubing} = 3.14 \times 0.29^2 \times 10 = 2.64 \mu\text{l}$$

3. Operate the pump for a known number of steps and measure the distance that the air space travels. Record the distance and repeat at least ten times.
4. Average the distance traveled for each trial.
5. Calculate the average volume per step by converting the average distance traveled to cm. Then, multiply that number by the volume per cm of the tubing. This gives the average volume infused. Divide this number by the number of steps, and this is the average volume per step. For example, if the pump is run for 50 steps and the average mm traveled is 4.47 the calculation will go as follows:

$$\text{Average Distance Traveled} = 4.5 \text{ mm} = 0.450 \text{ cm}$$

$$\text{Average Volume Infused} = 0.450 \text{ cm} \times 2.640 \mu\text{l/cm} = 1.188 \mu\text{l}$$

$$\text{Average Volume per Step} = 1.188 \mu\text{l} / 50 \text{ steps} = 0.024 \mu\text{l/step}$$

So for the pump in this example, the average volume per step is 0.024 microliters, or 24.0 nanoliters.

NOTE: If the jumper on the J1 connector inside the Pump Controller (Figure 2.15) is in the 2.1 or 2.2 position, the pump will be operating at ½ or ¼ step. It is important to note that the volume infused per step will decrease accordingly.

CHAPTER 3

Operating Instructions

Pump Travel

Because of the PHM-109's compact size, the amount of volume that can be infused in a single injection is limited. It is recommended that the maximum number of steps per infusion be 200. Exceeding this number of steps may cause the pump to reach the end of travel, which may cause damage to the pump motor.

Care should be taken to ensure that the pump is at the beginning of travel prior to starting an infusion, as shown below in Figure 3.1. When the pump reaches the end of travel, shown in Figure 3.2, it should be disconnected from the animal and primed (see the Priming the Pump section of this manual).

Figure 3.1 - Beginning of Pump Travel

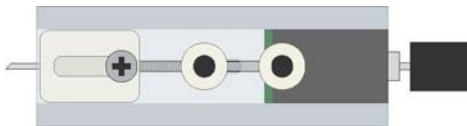
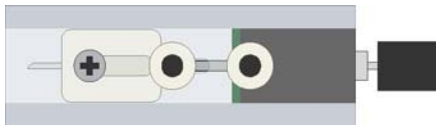
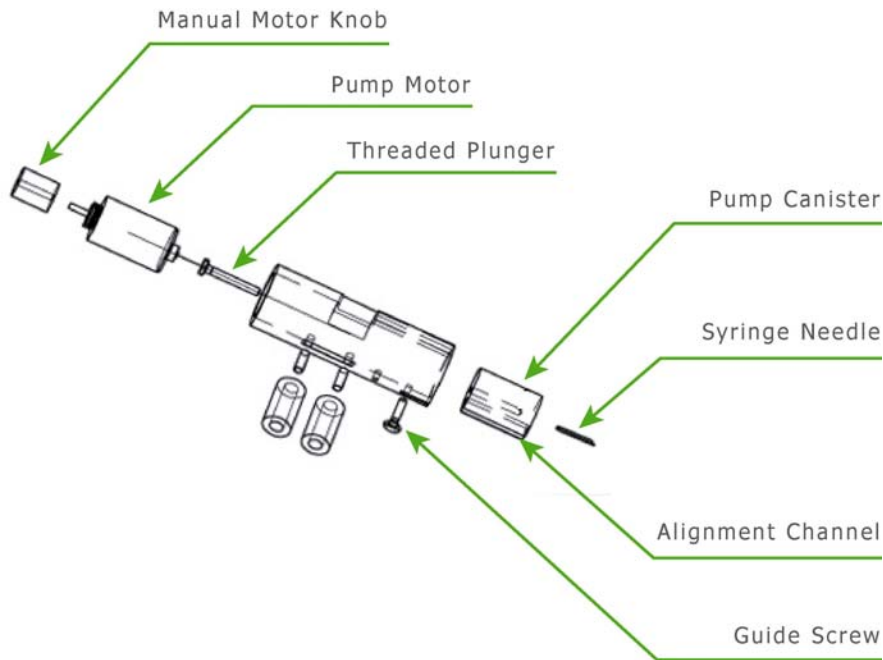


Figure 3.2 - End of Pump Travel



Loading the Pump

Figure 3.3 - Pump Assembly



Before each session the injector tubing and the pump canister must be filled with the infusion solution. Fill the injector tubing assembly by connecting a 1 cc syringe filled with the infusion solution. Inject the infusion solution into the injector tubing, being sure that there are no air bubbles present. The pump canister can be filled by inserting the needle tip of the syringe into the syringe needle of the pump canister, while holding the canister vertically, syringe needle end down. Next, carefully connect the injector tubing to the syringe needle of the pump canister. The canister can now be connected to the threaded plunger by turning the manual motor knob 1-2 full revolutions, being sure that the guide screw is in the alignment channel.

Before connecting the pump to the animal, it is recommended that the pump be run, either using the MANUAL OPERATION button on the Pump Controller or by using MED-PC to step the motor, until there is fluid at the end of the injection cannula (see the Priming the Pump section of this manual). Next remove the dummy cannula from the guide cannula and connect the PHM-109 Intracranial Pump to the animal.

MED-PC Controlled Operation

The PHM-109 Intracranial Pump can be controlled easily using MED-PC. A sample program is shown below:

```
S.S.1,  
S1, \ A is the number of steps per infusion  
    #K1: SET A = 50, b= 0 ---> S2  
    #K2: SET A = 100, b = 0 ---> S2  
    #K3: SET A = 150, b = 0 ---> S2  
  
S2,  
    0.50": ADD B; ON 1 ---> S3  
  
S3, \ one step will take 500 ms  
    0.50": OFF 1; IF B >= A [@End, @Cont]  
           @End: ---> S1  
           @Cont: ---> S2
```

In the example above the pump can be run at either 50, 100 or 150 steps. Each step will last five hundred milliseconds.

NOTE: It is recommended that the maximum number of steps per infusion be 200. The pump may not function properly if this number of steps is exceeded.

It should also be noted that the setting of the MOTOR DIRECTION switch (Figure 2.3) on the Pump Controller is not recognized when the pump is being controlled by MED-PC.

Priming the Pump

The Manual Operation function of the PHM-109 Intracranial Pump is intended to be used only for the purposes of priming the pump and tubing. It is not possible to accurately calculate the volume infused when operating manually. The 28 VDC Inverter must be connected to the Pump Controller in order for the pump to function in Manual mode.

NOTE: The SG-216A cable supplies power to the pump when connected to a MED-PC Output, therefore connecting the 28 VDC Inverter and the SG-216A cable to the Pump Controller concurrently may cause equipment damage.

To operate the pump manually, simply press the **MANUAL OPERATION** button (Figure 2.3). The pump will operate for as long as this button is held down. The direction of the pump can be changed using the **MOTOR DIRECTION** switch (Figure 2.3).